

Temporomandibular Joint Disorder: Current Status

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Abstract : The temporomandibular joint (TMJ) is a synovial bi-condylar joint with 3 degrees of freedom. One-third of the adult population reportedly suffers from temporomandibular joint dysfunction (TMD). Females are more commonly affected than males. Almost 50% of TMD patients do not require any intervention, and the symptoms are self-limiting within one year after the onset. The clinical features of TMD are clenching, clicking, and locking of the jaw, and occlusion due to faulty posture. This article aims to provide an overview of TMD and examine available treatment strategies for TMD. Various conservative treatment methods have been proven to be effective, including self-care strategies, dental treatment strategies, pharmacological treatment, physical therapy modalities, manual mobilization, electrotherapy and dry needling, relaxation techniques. **AIM:** To Present an overview of most recent developments in aetiology, epidemiology, diagnosis and treatment of TMD. **CONCLUSION :** Depending on the type of TMD, many treatment modalities have been proposed, ranging from conservative options to open surgical procedures. In this article we discuss the recent/ current controversies etiology, diagnosis and treatment plan for TMD patients. **Keywords:** Temporomandibular joint, TMD, Orthodontics.

INTRODUCTION

The temporomandibular joint (TMJ) is a synovial bi-condylar joint with 3 degrees of freedom. The temporomandibular joints connect your lower jaw to your skull along each side of your head. When they work well, they enable you to talk and chew. The TMJ combines a hinge action with sliding motions.¹ Temporomandibular disorders are musculoskeletal or neuromuscular condition that related to muscles, joints and the associated structures of stomatognathic system (*Martina Ferrillo*). The parts of the bones that interact in the joint are covered with cartilage and are separated by a small disk, which normally keeps the movement smooth. Temporomandibular joint disorder (TMD) is a broad term encompassing various problems associated with the temporomandibular joint. One-third of the adult population reportedly suffers from temporomandibular joint dysfunction (TMD). 95% Females are more commonly affected than males. 75-80% of adults suffering from TMD require medical intervention and it takes up to three years for the complete remission of the symptoms (*Om C. Wadhokar 2022*). The standard clinical features of TMD include pain in the TMJ and surrounding

tissues, which leads to the functional limitation of the Joint. Most adults presenting with TMDs are self-remitting, while some require conservative interventions such as physical therapy and medications. The contributing factors for TMD include teeth clenching, muscular pain, and occlusion of the TMJ due to faulty posture, which predispose individuals to TMD in the long term.² TMJ is a synovial joint with excellent mobility and stability. The articular surfaces maxilla and mandible are covered with a fibrous connective tissue. There is a joint disk between the articular surfaces. The mobility to the TMJ is provided by the articular disk, which enables us to perform all the activities of daily living such as speaking, swallowing, and chewing effortlessly. Orofacial pain refers to pain over the face, oral cavity, TMJ, and soft tissues, which is a significant cause of non-odontogenic orofacial pain (*Dion Tik Shun Li 2021*). The TMD significantly impacts the individual's physical and psychological well-being. TMD treatment can involve high economic costs leading to depression and psychological affliction. Prior to 2000, clinicians considered malocclusions to be the leading cause of TMD; later on, in early 1990, it was found that role of

malocclusion in TMD was minimal³. Surgical procedures for TMDs increased significantly in 2010, but due to a lack of evidence on arthrocentesis for TMD, the use of operative procedures has reduced significantly. In recent years, biopsychosocial models have been used ((*Om C. Wadhokar 2022*). In addition to being the most common type of non-odontogenic orofacial pain, TMD pain is major drive of treatment seeking (*Flavia PenteadoKapos, Fernando GustavoExposto, Juan Fernando Oyarzo*

EPIDEMIOLOGY

A large population-based study using the RDC/TMD estimated the prevalence of painful TMD (myalgia and/or arthralgia) is 36% in adults aged 20–49 years. TMJ ‘clicking’ was reported by 30% of adults, while only 8% were diagnosed with a disc displacement (DD).⁴The estimated prevalence of TMD degenerative joint disease (DJD) diagnosis, also associated with TMJ noises, is 17%. Of note, TMJ DD, the presumed cause of TMJ ‘clicking’, has been argued to be a normal anatomical variant of TMJ disc position, given its high prevalence in asymptomatic populations(*FlaviaPenteadoKapos, Fernando Gustavo Exposto, Juan Fernando Oyarzo, Justin Durham 2022*)

Table 1: Epidemiology of TMD

Epidemiology	TMD
4%	18-44 Age group
2.5%	18-25 year age group
3.7%	25-34 year age group
4.5%	35-44 year age group
19%	Adults(have symptoms of painful TMD)
3%	12-19 Year age group
95%	12-19 year female have high risk of TMD
36%	Adult 20-49 year age group
30% Adult	While 2% diagnosed with disc displacement

ETIOLOGY

TMD affects up to 15 to 20% of adult patients, with a peak incidence at 20 to 40 years of age. It tends to be more common in women. The cause of TMD is multifactorial and includes biologic, environmental, social, emotional, and cognitive reasons(*Dion Tik Shun Li 2021*).⁴

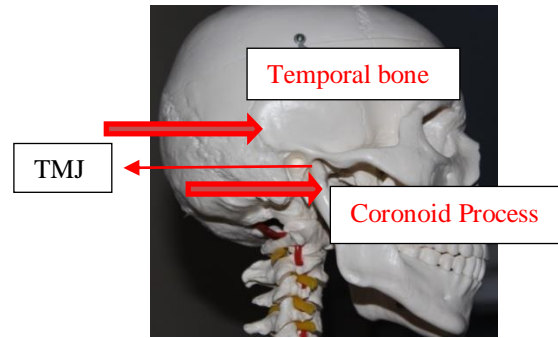


Fig 1: Temporomandibular joint

Table 2: Etiological Factors

• Bruxism
• Malocclusion
• Unilateral chewing
• Trauma
• Abnormal function
• After long-standing dental treatment
• Sleep on stomach
• Abnormalities in the intra articular disk
• stress, anxiety
• Epileptic seizure
• Osteoarthritis

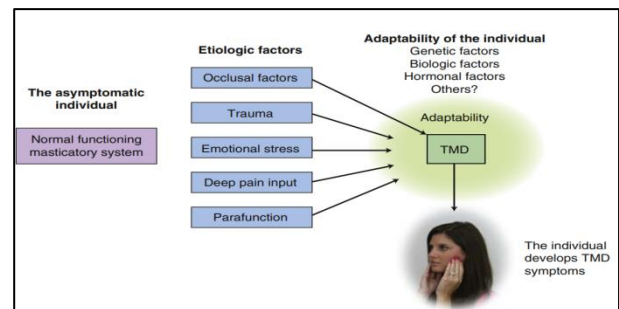


Fig 2: Etiological factors

SYMPTOMS

A malfunction is an expression of disturbance of functional activities that can provoke patients to make adaptive changes. TMD corresponds, then, to pain and dysfunction in the masticatory system related to musculoskeletal anomalies and can refer to either or both of the affected systems (muscular and articular).⁴

Table 3: Symptoms

• Painful and non-painful comorbid conditions
• Headaches, neck and back pain, irritable bowel syndrome, insomnia, depression, anxiety and tinnitus

<ul style="list-style-type: none"> • TMD cases in children, adolescents and adults.
<ul style="list-style-type: none"> • Somatic awareness and increased pain sensitivity (including in non-trigeminal areas)
<ul style="list-style-type: none"> • Pain, reduced jaw mobility, headache, neck pain or stiffness, teeth grinding, and pain with mouth opening
<ul style="list-style-type: none"> • jaw muscle soreness, creaks when opening or closing the mouth
<ul style="list-style-type: none"> • Pain in the cervical area neck mass, frequent headaches, and pain in the dental arches
<ul style="list-style-type: none"> • Temporomandibular disorders are worsened by stress and psychosocial problems
<ul style="list-style-type: none"> • Endogenous pain modulation.
<ul style="list-style-type: none"> • All these symptoms can be disabling and occur during chewing and when the patient yawns or even speaks

Disc displacement with reduction with intermittent locking	Clicking in the TMJ with reported episodes of limited mouth opening
Disc displacement without reduction with limited opening	Limited mouth opening affecting function, with maximum assisted opening < 40mm
Disc displacement without reduction without limited opening	Limited mouth opening affecting function, with maximum assisted opening of ≥ 40 mm
Degenerative joint disease	Crepitus of the TMJ upon function
Subluxation	History of jaw locking in an open mouth position, cannot close without a self-manuever

DIAGNOSIS

An essential first step is making an exclusion analysis, ruling out non-TMD pathology whose prognoses could be far more serious 2 conditions are there painful and non-painful.

Table 4: Diagnosis¹

Painful Conditions	Clinical Findings
Myalgia	Familiar pain in the masseter or temporalis upon palpation or mouth opening
Local Myalgia	Familiar pain in the masseter or temporalis localized to the site of palpation
Myofascial pain	Pain in the masseter or temporalis spreading beyond the site of palpation but within the confines of the muscle
Myofascial pain with referral	pain in the masseter or temporalis beyond the confines of the muscle being palpated
Arthralgia	Familiar pain in the TMJ upon palpation or during function
Headache attributed to TMD	Headache in the temple upon palpation of the temporalis muscle or during function

Table 5: Diagnosis

NON - Painful Conditions	Clinical Findings
Disc displacement with reduction	Clicking in the TMJ upon function

The diagnostic criteria for TMD (RDC recommended diagnostic criteria /TMD) were used for diagnosing and grading TMD. The RCD/TMD is based on the bio- behavioural pain model, which consists of two axes. Axis I denote physical signs and symptoms such as painful myofascial disorders, disc sub-luxation, and arthritis, while axis II consists of psychological and disability factors. In the most recent version of RDC/TMD, new criteria were published, named DC/TMD, a more comprehensive instrument for both axes for researchers and clinicians. Differential diagnosis: 55% of patients referred to a neurologist with chronic headaches were found to have significant signs and symptoms of TMD

Axis I

For more specific TMD diagnoses, the diagnostic criteria /TMD requires a physical examination. This has been described in detail with the commands and procedures being validated in several different languages. The 12 most common TMD diagnoses, most of which have established sensitivity and specificity, are: myalgia (local myalgia, myofascial pain, myofascial pain with referral), arthralgia, four types of disc displacement disorders, degenerative joint disease, subluxation and headache attributed to TMD. It is important to note that an individual may present with multiple simultaneous painful and/or non-painful TMD diagnoses. An expanded version of the DC/TMD including less common TMD is also available. It should be stated that sensitivity and

specificity for most of the less common conditions have not yet been established.

Axis II

Studies have shown that TMD patients present with a higher psychosocial burden and frequency of comorbid conditions than TMD-free individuals and that these conditions can lead to persistence and aggravation of TMD pain. Consequently, it is important to assess these parameters when managing TMD patients, which can be done through validated instruments recommended in the Axis II of the DC/TMD. These instruments assess, among other things, pain behaviour, psychosocial status and functioning which can highlight contributing factors and guide tailored treatment decisions.

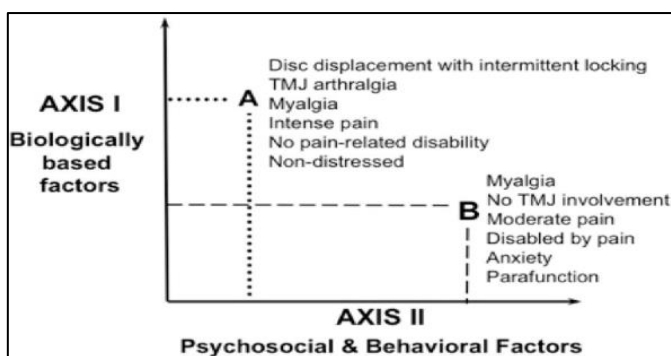


Fig. 3: Axis I & Axis II

Clinical and Research Applications of Selected DC/TMD Axis I and Axis II Tests				
	Axis I: Physical diagnosis		Axis II: Psychosocial status	
	Pain diagnoses	Joint diagnoses	Distress and pain disability	
Application	Clinical or research		Clinical	Clinical or research
Screening test	TMD pain screener	DC/TMD for disc displacements, degenerative joint disease, and subluxation	PHQ-4 and GCPS	PHQ-9, GAD-7, PHQ-15, and GCPS
Confirmatory test	DC/TMD for myalgia, arthralgia, and headache attributed to TMD	Imaging: MRI for disc displacements, CT for degenerative joint disease, and panoramic radiographs, MRI, or CT for subluxation	Consultation with mental health provider	Structured psychiatric or behavioral medicine interview

Fig 4: clinical application of Axis I and Axis II

NEW METHODS OF TMD DIAGNOSIS

1) Novel Artificial Neural Network For TMD Diagnosis

Artificial intelligence (AI) is primarily used within the medical field to aid in the diagnosis and treatment of life-threatening conditions such as cardiovascular disease and cancer. Although TMD has a similar prevalence to these conditions in the

general population, the use of artificial intelligence for the diagnosis and treatment of TMD is still in its infancy.

While TMD is not itself a life-threatening condition, TMD can present with similar symptoms to life-threatening conditions. In fact, 4% of acute myocardial infarctions present with pain in the craniofacial structures as the only symptom ((*Brendan Moxley , William Stevens 2023*)) This program allows the input of multiple pieces of information (patient symptoms, diagnostic imaging, etc.) and creates an output (diagnosis). The Kreiner ANN was given the same patient scenarios as general dentists and asked to determine whether the patient's pain was of orofacial origin, and if so, to properly diagnose the condition.

The neural network was clearly superior at diagnosing pain from outside the orofacial region (e.g., referred cardiac pain, neuropathic pain). For example, only 25% of clinicians could diagnose the cases of referred orofacial pain from myocardial infarctions(*Brendan Moxley , William Stevens 2023*)

Table 6: Novel Diagnostic and Therapeutic approaches in TMD

Novel diagnostic	Novel therapeutics
All neural networks	Aromatherapy massage
Salivary Endocannabinoid	Masticatory muscle relaxation technique
Electronic signal analysis	Radial extracorporeal shock wave therapy
MRI scanning system	Light vs LASER therapy
Functional indices of masticatory activity	

2) Salivary Endo Cannabinoid Profiles

Each individual possesses a unique endocannabinoid (eCB) profile within their saliva. It has been suggested that this eCB profile may indicate the presence of underlying conditions that cause pain, such as temporomandibular disorder. Saliva samples were collected from all participants, and salivary levels of endocannabinoids and related compounds were analyzed using liquid chromatography–tandem mass spectrometry.

Patients who currently suffer from migraines had significantly lower levels of an eCB called PEA in their saliva. There was a significantly increased level of AEA in the saliva of patients who suffer from burning mouth syndrome. There were not significantly increased or decreased levels of any specific eCBs in the temporomandibular disorder or post-traumatic neuropathy patients ((*Brendan Moxley, William Stevens 2023*)¹¹)

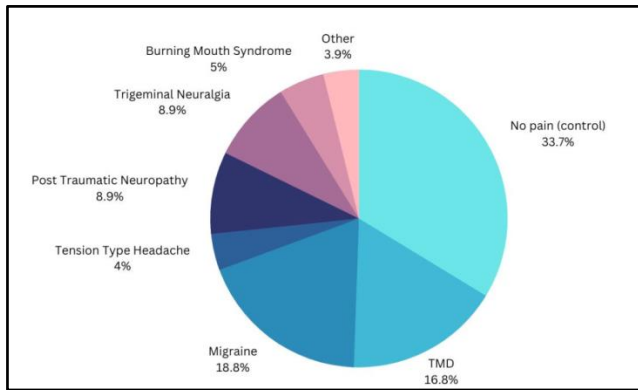


Fig 5: differential diagnosis of TMJ pain

COVID 19 and TMD

- The coronavirus belongs to the family of Coronaviridae, COVID-19 creates respiratory problems and infections that range from mild to severe.
- During the 2000s, two viruses of animal origin were caused by species shifting, the severe acute respiratory coronavirus syndrome (SARS-CoV-1) and the Middle East respiratory coronavirus disease (MERS-CoV).
- Temporomandibular disorders are characterized by jaw joint and jaw muscle soreness, clicks, or creaks when opening or closing the mouth COVID-19 pandemic may have increased the incidence of temporomandibular disorders is perceived.
- Indeed, this sense of uncertainty and a lack of confidence in medical therapy and in the various governments to stem the pandemic situation have exacerbated the incidence of COVID-19.⁸
- Incidence studies have reported an increase in bruxism and joint pain, all due to increased uncertainty, and stress caused by job loss or separation from family members.

- In fact, the increased stress, anxiety, and depression induced by the pandemic situation have increased the incidence of symptoms of joint disorders. On the other hand, people with temporomandibular disorders are more susceptible to anxiety due to COVID-19 and increased joint pain..
- Therefore, the importance of this review, in addition to confirming that there is a correlation between anxiety and COVID-19 stress, has an important clinical implication in that the treatment of these patients requires a multidisciplinary approach (dentist, psychologist, and physician) in order to properly treat this condition.¹²

TREATMENTS

It becomes very important to recognize the underlying cause of psychological disorder which many dental practitioners are not often trained for leading to uncertainty. Nevertheless, dental surgeons who attempt to treat TMDS should be able to appreciate these problems and effectively identify the cause so that a multidisciplinary approach of treatment can be done with appropriate referrals⁸

Table 7: Treatment approaches

Non invasive treatment	Invasive treatment approach
Education, self-care	Intra articular injection
Pharmacological intervention	Orthodontic manipulation
Topical ointment	Dry needling
Occlusal splint	Acupuncture therapy
Bio behavioural approach	Surgical interventions

The orthodontic and surgical approaches will permanently alter the joint anatomy, and hence they are avoided in several cases, and patients go for conservative therapies such as physical therapy, pharmacotherapy, occlusal splints, behavioural approach, and self-care. Almost 50% of individual’s symptoms remit within one year while 85% of the population suffering from TMD recovers completely in three year, the signs and symptoms of TMD may mimic other orofacial pain conditions. Although precise physical diagnosis into the type of TMD is helpful in developing an

appropriate treatment plan, it might not be straight forward in every case. Taking a patient's history is an important part of diagnosing the TMJ condition. The acquisition of history follows the usual format. Apart from the chief complaint, inquiries should be made regarding any history of trauma or previous episodes, aggravating factors, such as eating, talking, yawning or spontaneous background pain, and any previous investigations or treatment. The severity of pain should also be graded using a visual analogue scale (VAS), so treatment progress can be quantitatively monitored. Most clinicians who treat orofacial pain believe clinical examination is the most crucial process of diagnosing TMD. The location of pain, and whether the pain is localized, remains within or spreads beyond the confines of the muscle, should be confirmed with palpation, which is done at rest and during mandibular function. Clicking or crepitus upon mandibular function might be quite obvious in some cases, and the detection might be aided by the use of a stethoscope.

There are some non-invasive treatment measures for TMD include medications, dental therapies, physiotherapy, and psychological treatment, which have been shown to improve the overall quality of life of the individual.⁸

1. Education and Self-Care

Self-awareness and education are very valuable and important for any treatment or pain management. A slight benefit is obtained with education when comparing this intervention with occlusal splints. This intervention approach, when compared with certain interventions like manual therapy and exercise, showed no additional benefits. Self-care is the mainstay of the treatment. It includes the prescription of simple exercises, and behavioural modifications.



Fig 6: Self care

2. Pharmacological Intervention

This intervention includes steroidal acetaminophen, and non-steroidal anti-inflammatory drugs, these drugs are helpful in treatment of acute and chronic pain; for muscular spasms and teeth-clenching muscles, relaxants are given, such as benzodiazepines. If this approach fails, then tricyclic antidepressants can help with pain and teeth grinding. Antidepressants used for chronic pain can also be used in the case of TMD. Care should be taken while prescribing selective serotonin uptake inhibitors; they might induce bruxism.

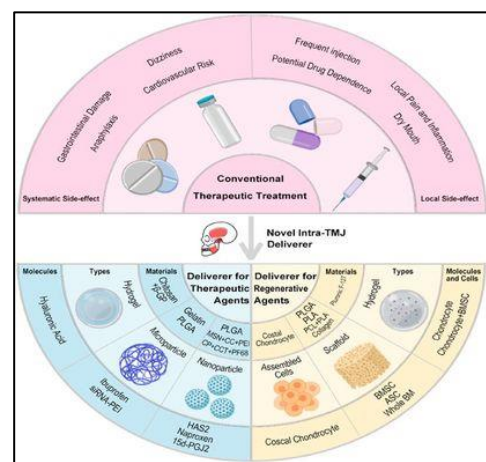


Fig 7: Pharmacological intervention

3. Intra-Articular Injections

Inflammation of the TMJ and the capsule can be resolved with local anesthetics or corticosteroids injection in the intra articular spaces. These injections are only used for severe acute exacerbation and after the failure of conservative treatments. A systematic review found non-significant evidence for repetitive intra-articular injections in TMD. Chronic bruxism and myofascial pain can be treated with local anesthetics and botulinum toxin. Out of five studies on the subject, two showed a prominent reduction in pain, one showed an equal reduction in pain with manual therapy, and the other two studies showed no significant reduction in pain with botulinum toxin compared to a placebo. More research is required to assess the long-term effect of BTX on the injected muscles. The research has shown the size of the muscle being recovered, but also demonstrated the loss of the contractile function; after one year of BTX injection and placebo injection for trapezius

muscle pain, there was no difference in the pain intensity measurement.



Fig 8: intra- articular injections

4. Dental Therapies

Dental occlusion splints and permanent dental adjustment are the mainstays of the treatment; the splints are selected based on the condition. The occlusal splints are used to correct the alignment of the upper and the lower teeth, and the non-occluding splints are mainly used for mouth opening, releasing muscle tension, and grinding of teeth. The cost of non-occluding splints is high, and hence very few can afford the splint. Permanent occlusion adjustments are made by professional orthodontics.

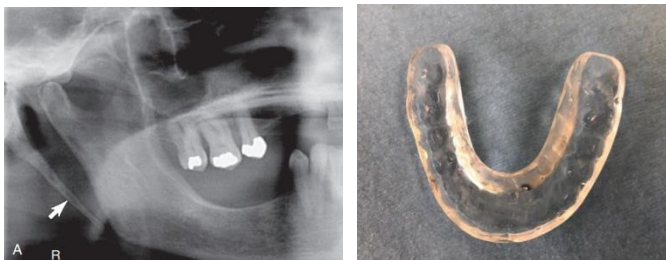


Fig 9: Dental therapy

5. Physical Therapy

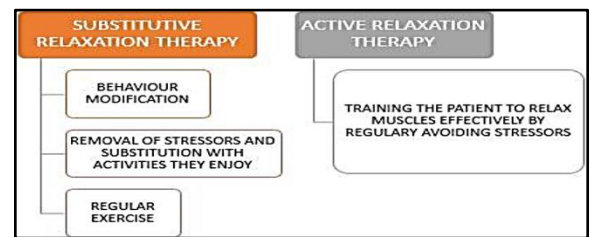
This therapy plays an important role in reducing pain, improving joint mobility, restoring motor functions, and reducing inflammation to relieve the symptoms of TMD. The intervention includes several types of exercise. Rocabado exercises: in these, the patient is instructed to put the tongue on the roof of the mouth and take six deep breaths followed by a sequence of exercises. Goldfish exercises: in this exercise, the individual is asked to put his tongue to the roof of the mouth and then place one index finger on the TMJ while the other on the chin. Range of motion exercises: this is done to relieve stiffness and improve symptoms. Joint mobilization: the joint restriction can be improved by manual joint mobilization by placing both the thumb on the molars, gently mobilizing the mandible for pain relief, and Improving the range of motion.



Fig 10: physical therapy/ Exercise

6. Cognitive Behavioural Therapy

It is one treatment approach available for patients suffering from TMD. This intervention, along with other conservative approaches mentioned above, helps to manage the thoughts, feelings, and behaviour that aggravate the symptoms. It plays a significant role in conjunction with other therapies treating the psychological causes of the pain.



7. Bio-Behavioral Approach

This approach is used for diagnosing and treating the patient with chronic TMD. It has been shown that psychological factors play an essential role along with pain history, current emotional and cognitive status, beliefs, learned behaviour, and tackling strategies. This approach allows the patient to acquire the ability to self-manage, leading to an improvement in overall functioning. Based on the recent clinical findings, the assessment, diagnosis, and treatment of TMD patients require a multidimensional approach, which the bio-behavioral approach provides. This model is designed for musculoskeletal disorders. This approach is based on the following objectives:

- (a) Reduction of pain perception,
- (b) Improvement of motor behaviour
- (c) Improvement of the cognitive and emotional factors related to the experience of pain

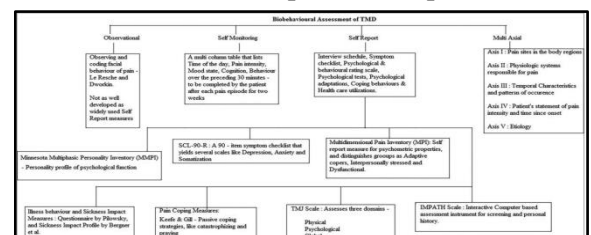


Fig 12: Bio-Behavioral Approach

8. Surgical Interventions/ Arthrocentesis

In various cases such as internal derangement, degenerative changes, and joint pathology, the arthrocentesis/arthroscopic approach is used. In the case of internal derangement, surgical intervention is not recommended, and a conservative approach and rehabilitation are recommended instead (fig 13). For other conditions like disk displacement, minimally invasive intervention is used. Recent evidence has shown that the injection of platelet-rich plasma and arthrocentesis is effective in osteoarthritis of TMJ. Arthrocentesis below from (Elif Bilgir 2020).

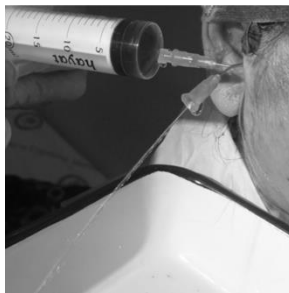


Fig 13: Arthrocentesis

9. Intraoral appliances

Several systematic reviews of the effects of occlusal appliances on TMD pain support that stabilisation splint (i.e. hard acrylic or soft polyethylene mouthguard providing full coverage of occlusal surfaces) worn on upper or lower teeth at night leads to short-term improvement when compared with no treatment, but evidence is inconclusive when compared with placebo (non-occluding palatal splint) (fig. 14). Additionally, stabilisation splints produced a similar improvement in TMD pain compared to physical therapy, behavioural medicine, and acupuncture. Partial coverage appliances such as the nociceptive trigeminal inhibition (NTI) and over the counter mouth-guards can be associated with adverse complications such as unwanted occlusal changes. Occlusal splint below from this study (Dion Tik Shun Li 2021, Brendan Moxley, William Stevens, Joel Sneed and Craig Pearl 2023).



Fig 14: occlusal splint

10. Psychological and multimodal therapies

A systematic review and meta-analysis of the effect of cognitive behavioural therapy (CBT) suggest long-term (>3 months) improvements in TMD pain, depression and interference with activities compared to 'usual care' (education, counselling and an stabilization splint), for CBT alone or in combination with biofeedback (fig. 15). Patients with TMD pain and major psychological symptoms may obtain more improvement with multimodal treatment than patients with TMD disc displacement and pain without major psychological symptoms. Biofeedback was found to be superior to active control and similar to relaxation training for reducing TMD pain, but did not add a significant benefit compared to CBT alone.⁹

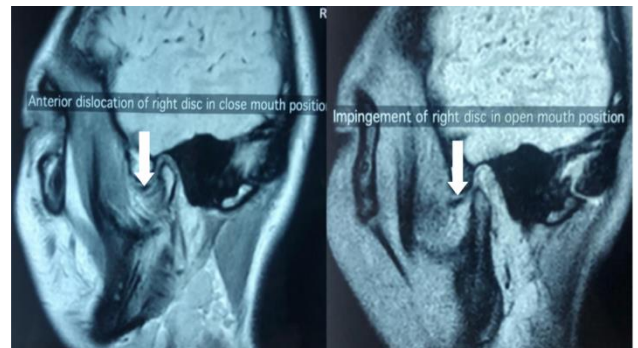


Fig 15: cognitive behavioural therapy

11. Acupuncture, dry needling and substance injection for TMD myalgia

Systematic review including four small RCTs of acupuncture (traditional, trigger point and laser) provides evidence for short-term improvement in TMD muscle pain compared to placebo acupuncture, as well as similar results to stabilization splint (fig. 16). Another systematic review and meta-analysis including 13 studies of TMD found improvements in TMD muscle pain for acupuncture compared to placebo (sham) acupuncture. Although a meta-analysis could not be performed due to heterogeneity of studies, a systematic review found support for short term improvements in TMD muscle pain for dry needling superior to false needling and to a combination of methocarbamol/ paracetamol, but similar to local anaesthetic injections. A systematic review with network meta-analysis revealed equivocal evidence for the effects of intra-muscular botulinum toxin injections for TMD muscle pain compared to

placebo injection. Further studies are needed to determine its efficacy, safety and cost-benefit⁹.

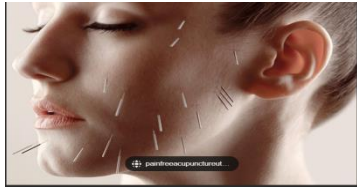


Fig 16: Acupuncture

CONCLUSION

- We conclude that like other musculoskeletal disorders, TMD, which also has a muscular origin, can be managed by the above-mentioned treatment modalities.
- One-third of the adult population suffers from TMD and it drastically affects the quality of life of the individual
- Conservative management is recommended for most TMD patients, which includes education, self-care, dental therapy, occlusal splints, intra-articular injections, topical ointments, pharmacotherapy and physical therapy
- Other management is dry needling, acupuncture therapy, electrotherapy, cognitive behavioral therapy, psychological treatment, and bio-behavioral approach.
- When all the conservative methods fail to reduce the symptoms, then surgical intervention is used.
- In cases of surgical corrections of the joint structure or soft tissue, after the surgical procedure, individuals should continue physical therapy for complete restoration of the function and return to normal lives.
- Pain modulation in TMD can be effectively achieved by pain medication, soft tissue mobilization, grade I and grade II joint mobilization, and electrotherapy modalities such as TENS and ultrasound.

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